

INITIAL RESULTS FROM THE 2004 NORTH SLOPE OF ALASKA ARCTIC WINTER RADIOMETRIC EXPERIMENT

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IGARSS'04

September 20-24 , 2004

MOTIVATION OF 2004 NSA/AAO EXPERIMENT

- Moisture and clouds in the cold, dry polar regions play key roles in climate feedback
- Development of accurate Radiative Transfer models requires accurate measurement of water vapor
- The accuracy of Radiosonde-derived humidity is difficult to access in arctic environments
- Both Microwave Radiometers and GPS are not sensitive to precipitable water vapor amounts ($PWV < 3 \text{ mm}$)
- Radiometers operating near 183.31 GHz offer greatly-enhanced sensitivity to vapor

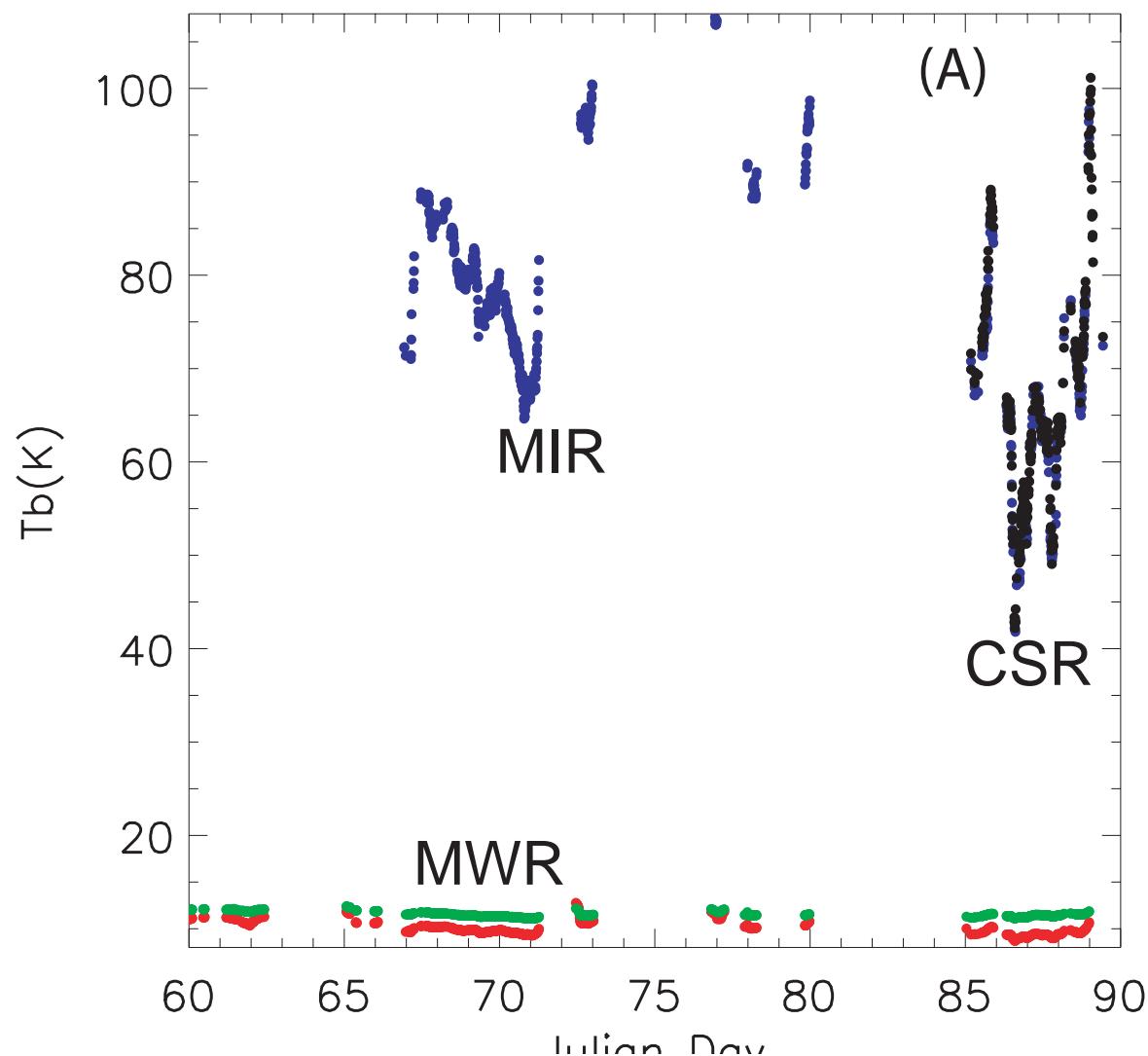
GOALS OF EXPERIMENT

NORTH SLOPE OF ALASKA
MARCH 9 TO APRIL 9, 2004

- Compare microwave vs. millimeterwave radiometric response to low amounts of water vapor and arctic clouds
- Obtain data for forward model radiative transfer studies at frequencies ranging from 22.235 to 400 GHz
- Demonstrate new ETL radiometric receiver and calibration technology
- Compare Chilled Mirror, Vaisala RS90 and VIZ humidity soundings

RESULTS AND RECOMMENDATIONS FROM NSA'99 EXPERIMENT

The theoretical basis of using 183 GHz radiometers to improve MWR retrievals of PWV at low amounts is sound.



RESULTS AND RECOMMENDATIONS FROM NSA'99 EXPERIMENT

(b) Substantial differences between modeled and measured brightness temperatures.

Causes:

Radiosondes?

Radiometric
Calibration?

Forward model
uncertainties?

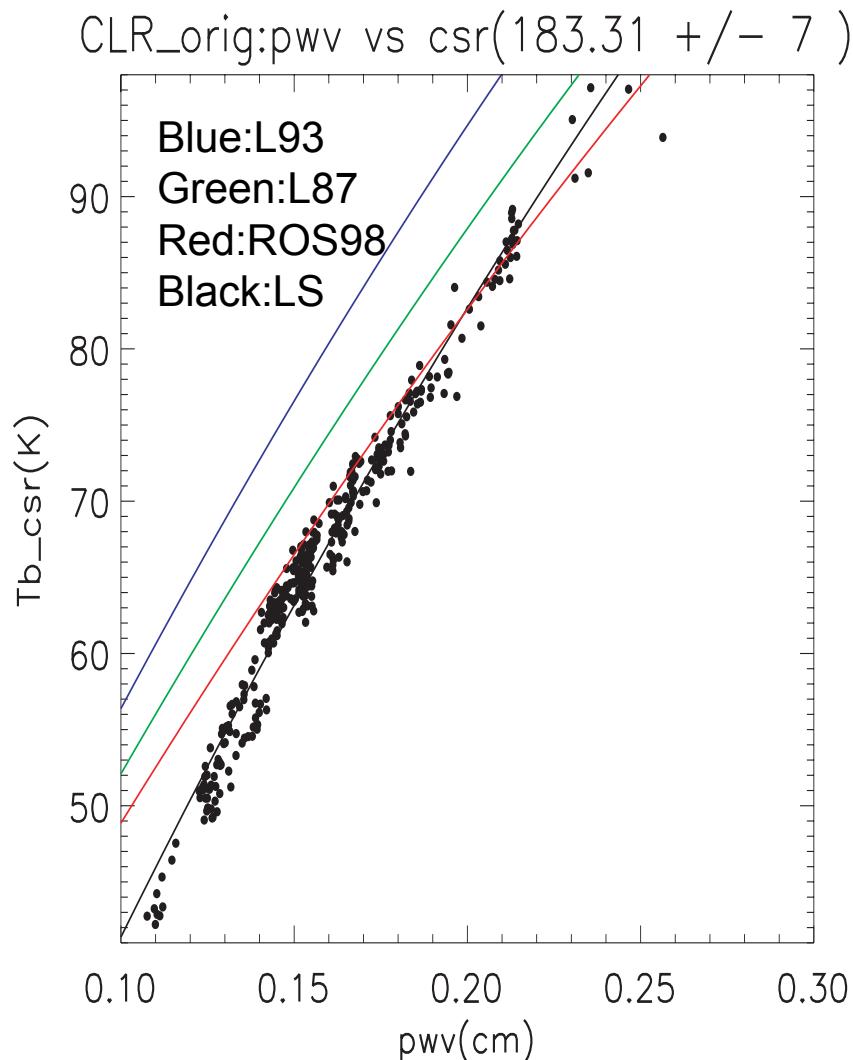


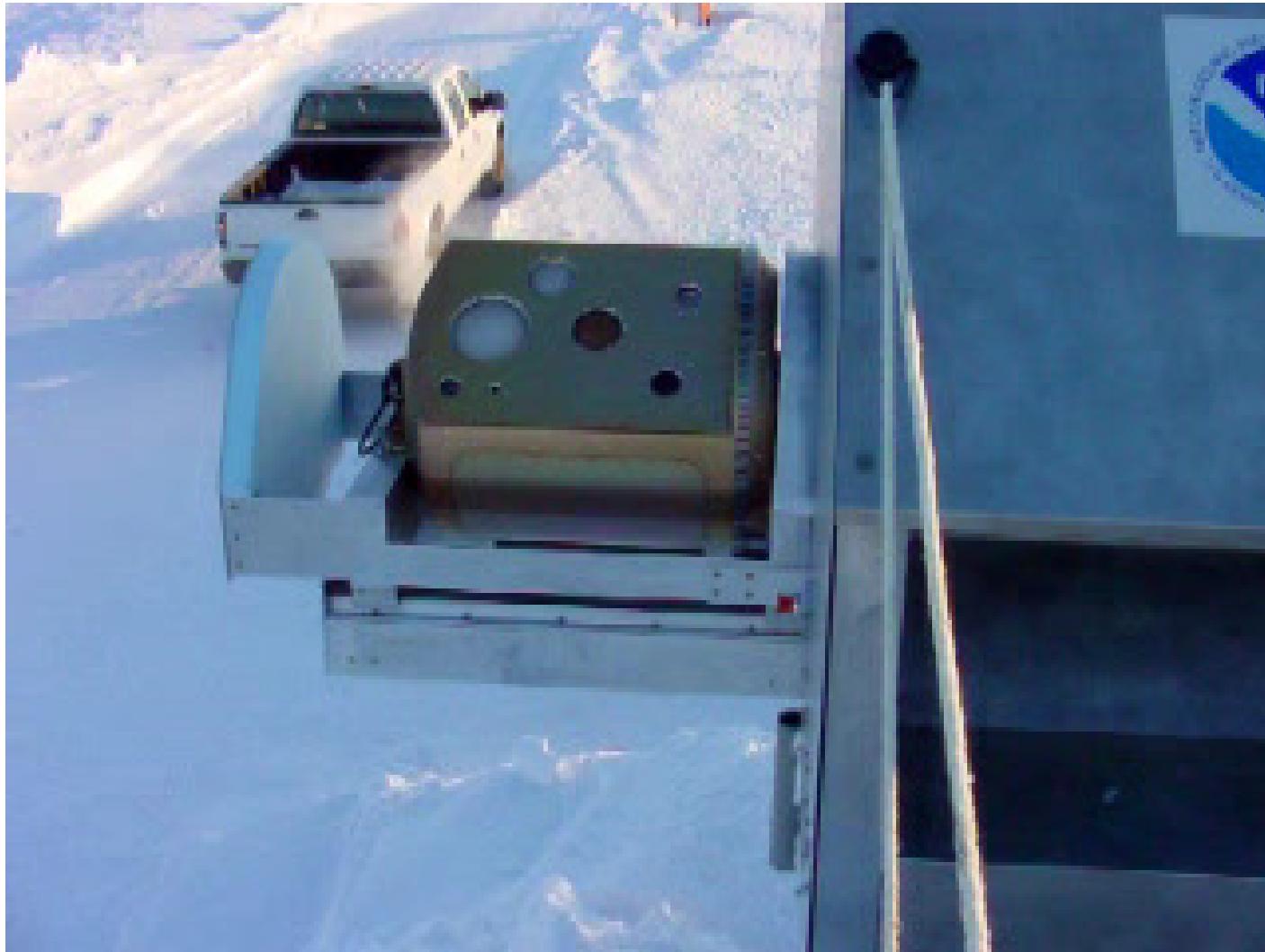
Table 1. Instruments deployed during the North Slope of Alaska Arctic Winter Radiometric Experiment'2004

Instrument	Parameters Derived	Frequencies (GHz)
ARM Radiometrics WVR	PWV, ICL	23.8, 31.4
Ground-based Scanning Radiometer (GSR)	PWV	$183.31 \pm (0.5, 1, 3, 5, 7, 12, 15)$
Ground-based Scanning Radiometer (GSR)	T, ICL	50.3, 51.76, 52.625, 53.29, 53.845, 54.4, 54.95, 55.52, 56.025, 56.215, 56.325
Microwave Profiler	T, PWV, ICL	22.235, 23.035, 23.835, 26.235, 30.000, 51.250, 52.280, 53.850, 54.940, 56.660, 57.290, 58.800
Ground-based Scanning Radiometer (GSR)	PWV, ICL	90 (dual-polarization)
Ground-based Scanning Radiometer (GSR)	PWV, ICL	340 (dual-polarization)
Ground-based Scanning Radiometer (GSR)	T, PWV	$382.2 \pm (4, 9, 17)$
Infrared Cloud Imager (ICI)	Spatial cloud coverage	8-14 microns
Ground-based Scanning Radiometer (GSR)	Cloud presence	10 microns
GPS	PWV	
4-times a day Vaisala RS90 Radiosondes	T and p profiles	
On demand: Frost Point "Snow white" Radiosondes with Chilled Mirror and VIZ humidity elements	T and p profiles	
2-times a day National Weather Service Radiosondes	T and p profiles	

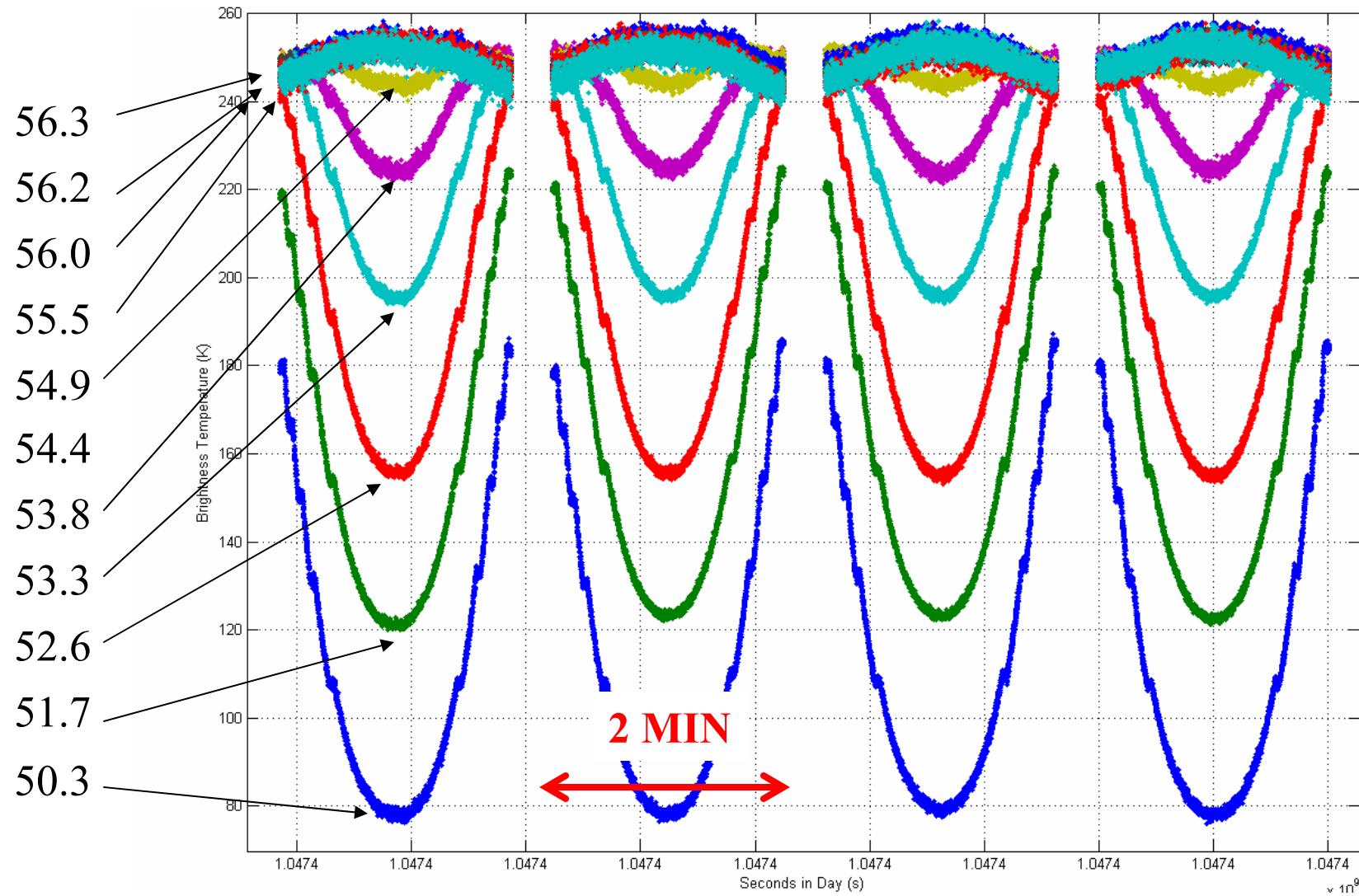
NSA04 INSTRUMENTS



GSR IN OPERATION

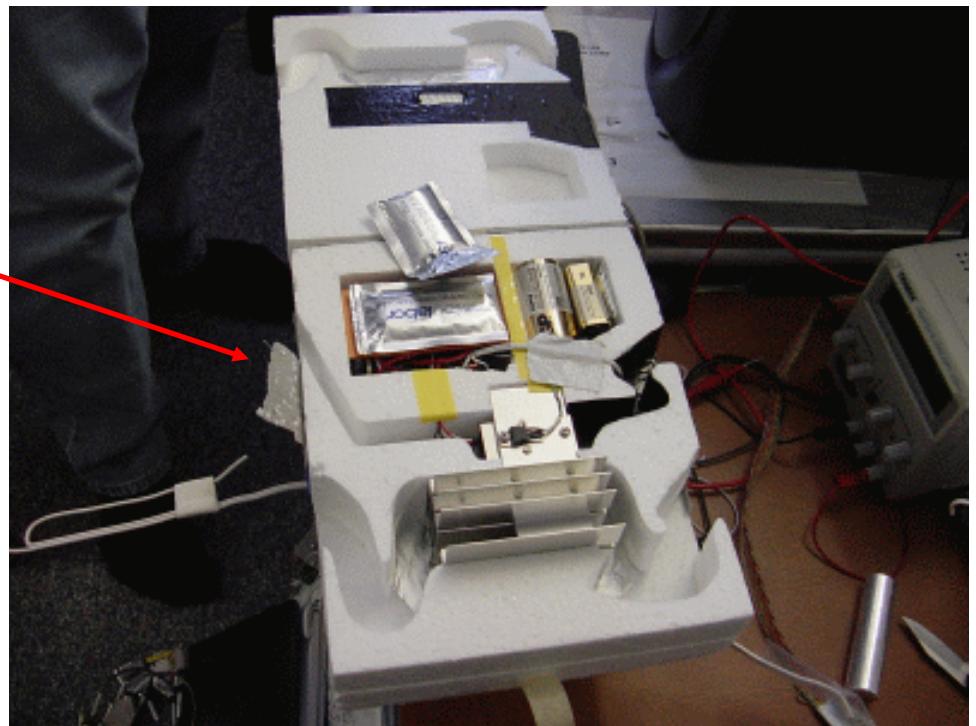


TIME SERIES OF GSR 50-60 GHz RADIOMETER CHANNELS

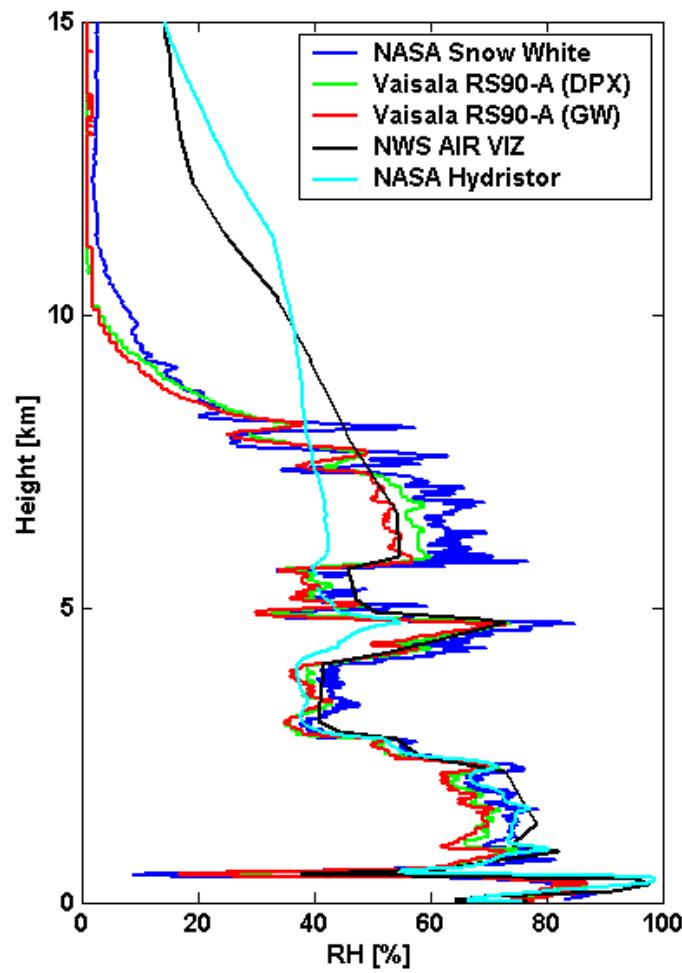
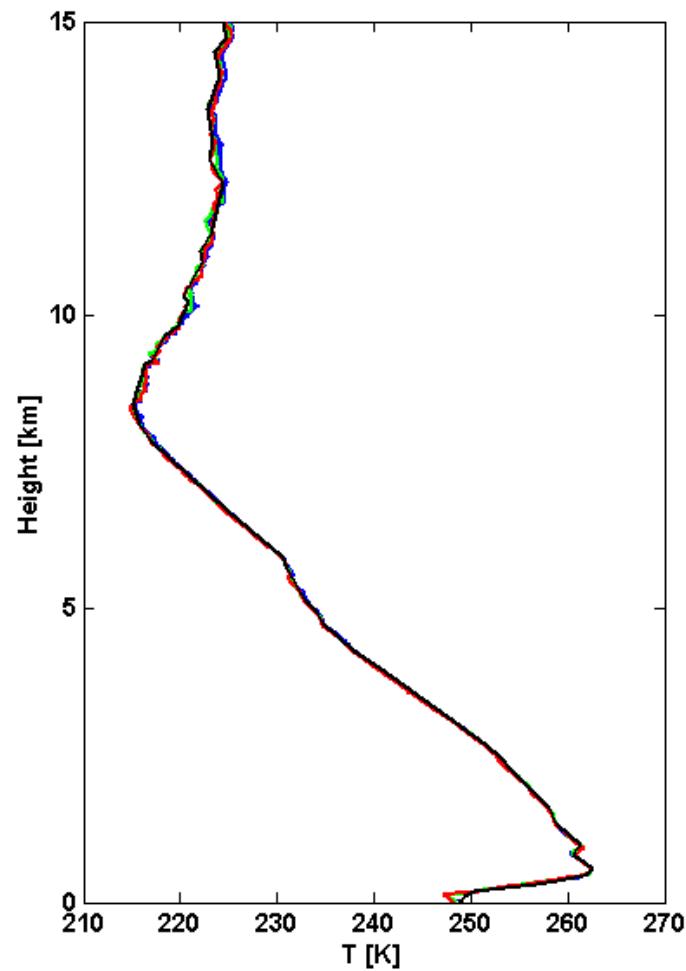




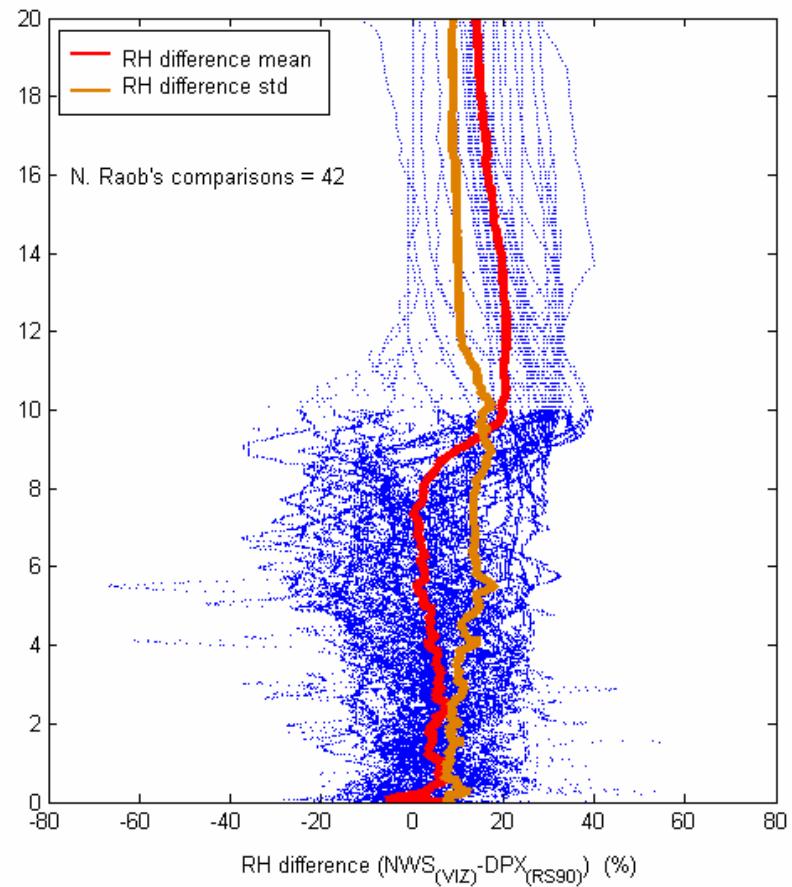
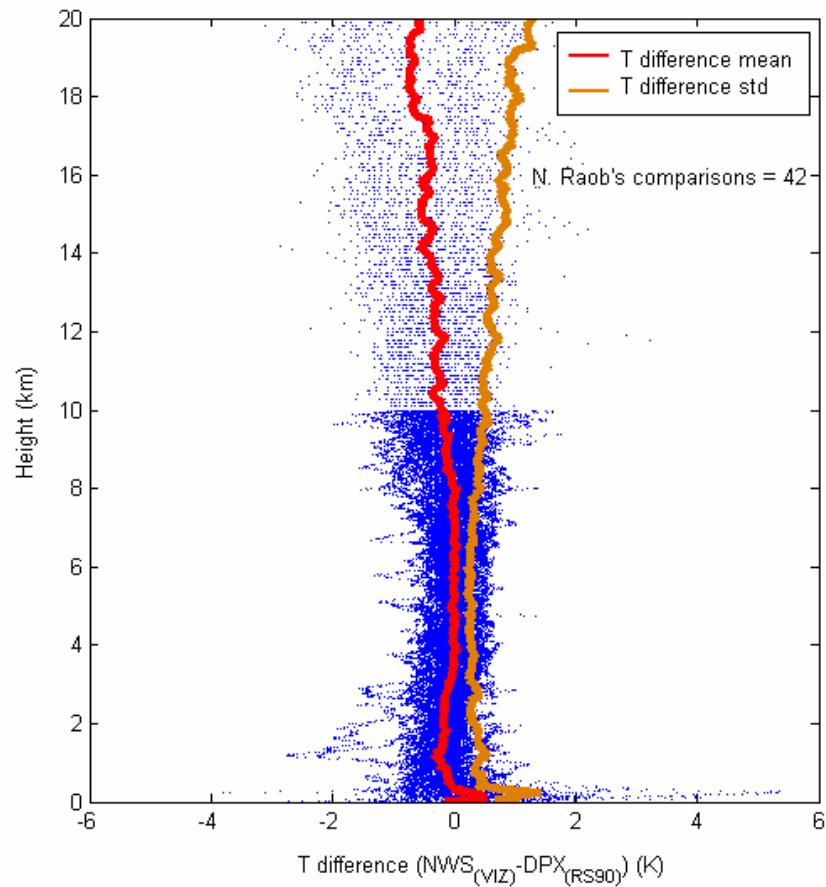
Dual-sonde launch: Vaisala RS90 and Chilled mirror (2004031101 UTC)



NSA AWRE WVIOP 2004 Dual Launch # 03 @ 2004031523



NWS VIZ VS. VAISALA RS90 T AND RH STATISTICS



**FORWARD MODEL AND RADIOSONDE COMPARISONS:
INPUT TO MODELS = T, RH, AND P FROM RADIOSONDES
CLEAR SKIES DETERMINED FROM CEILOMETER**

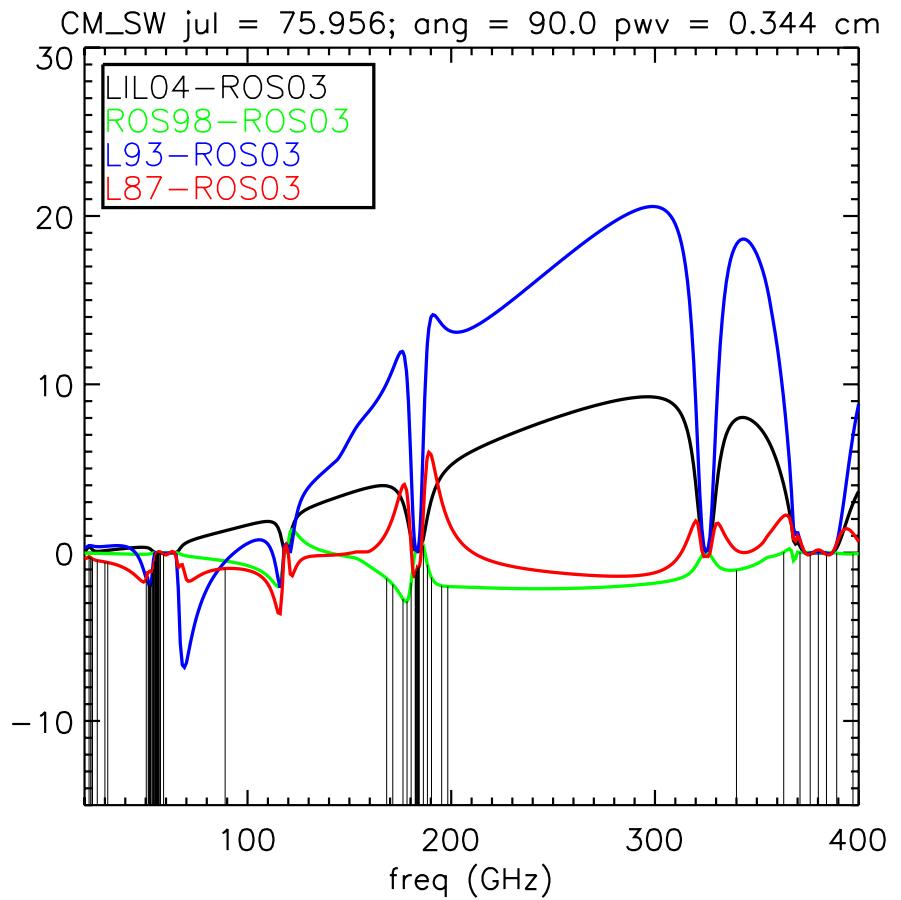
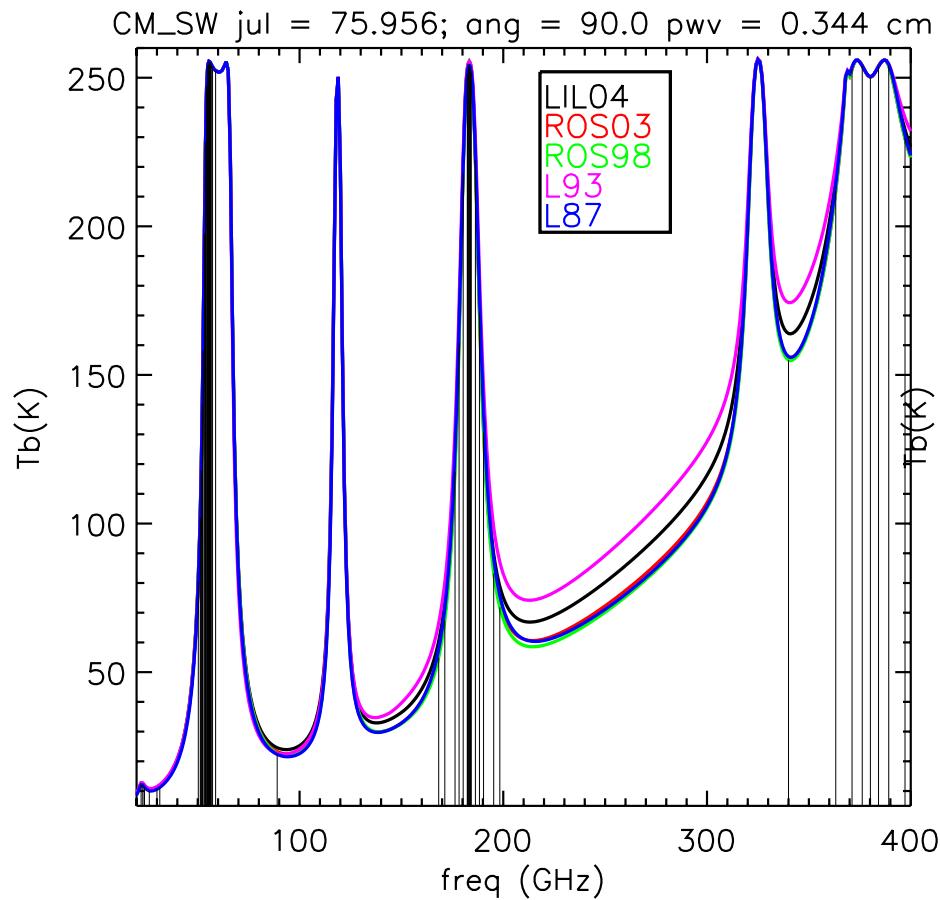
Models

- Liebe 1987
- Liebe 1993
- Rosenkranz (1998)
- Rosenkranz (2003)
- Liljegren (2004)

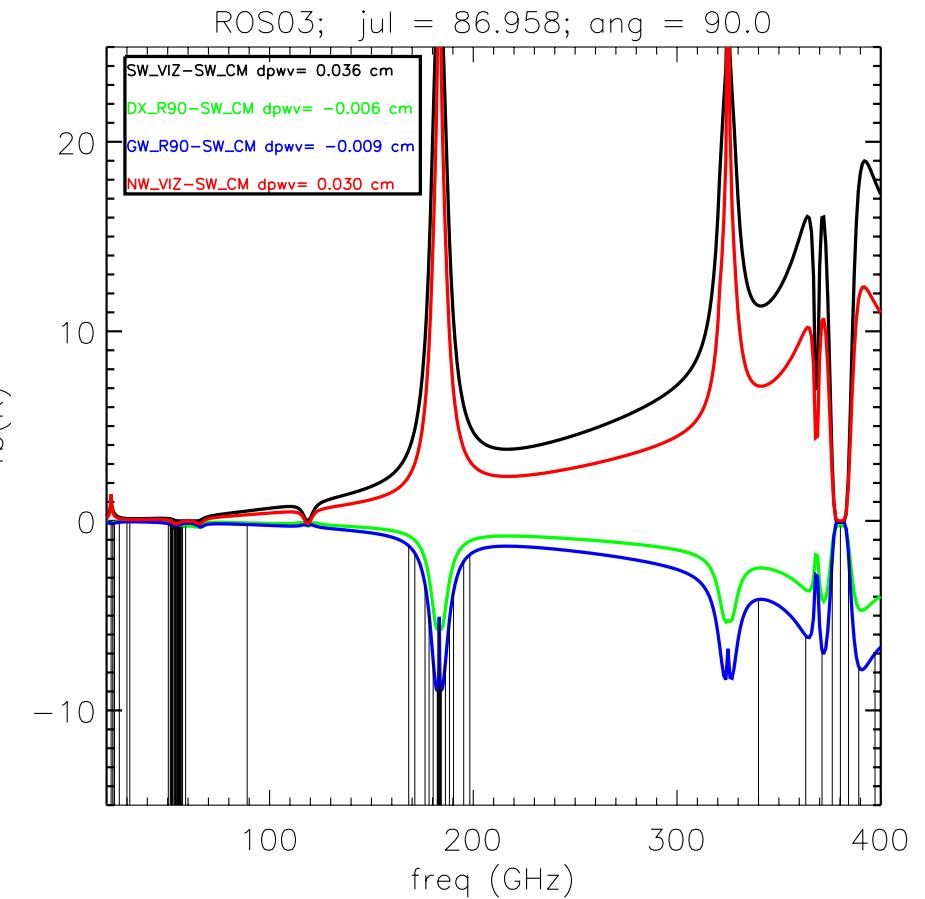
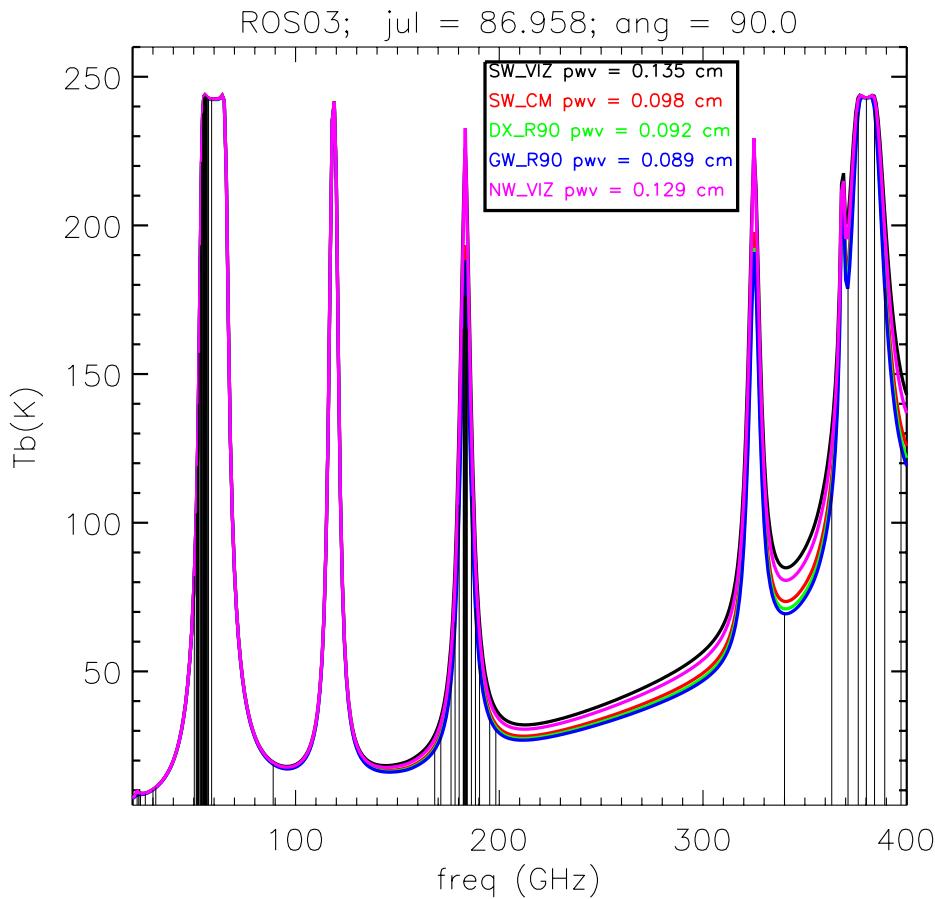
Radiosondes

- Vaisala RS90
- Chilled mirror
- VIZ

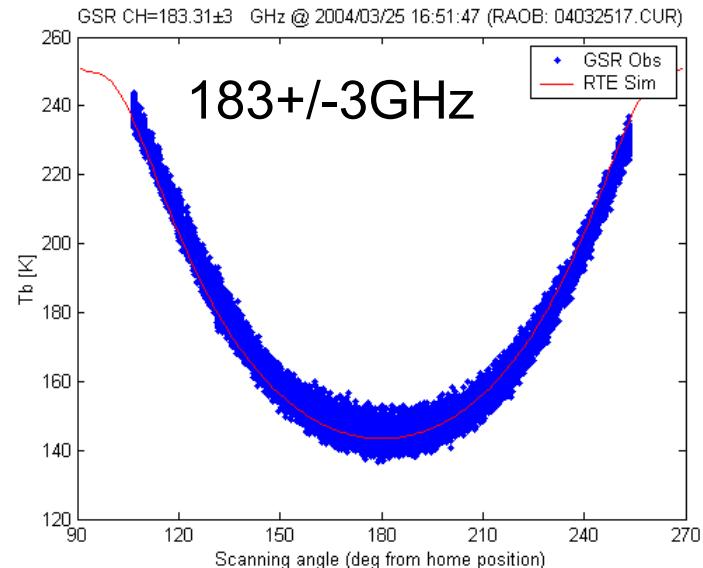
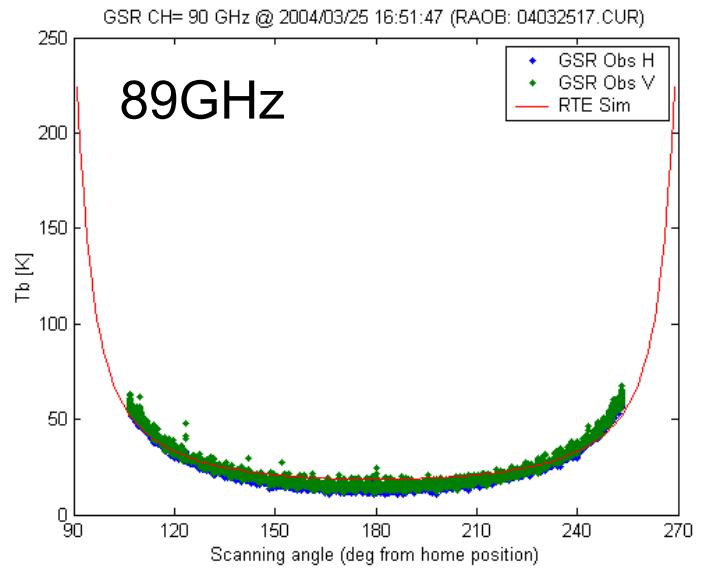
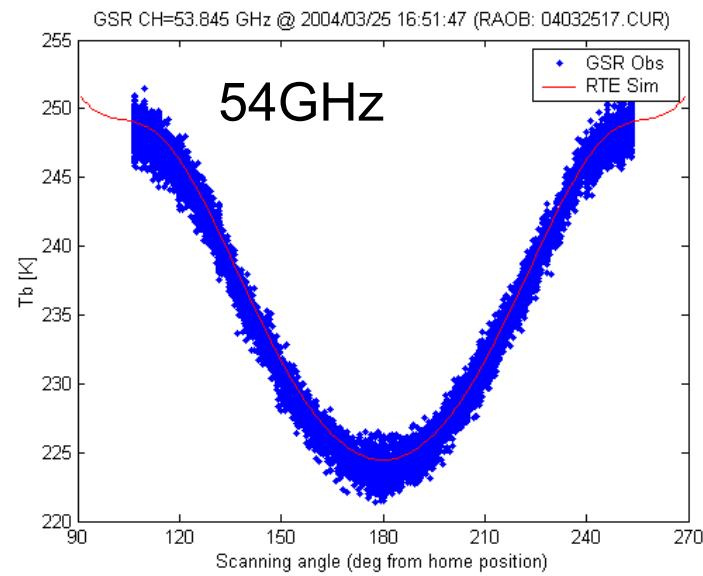
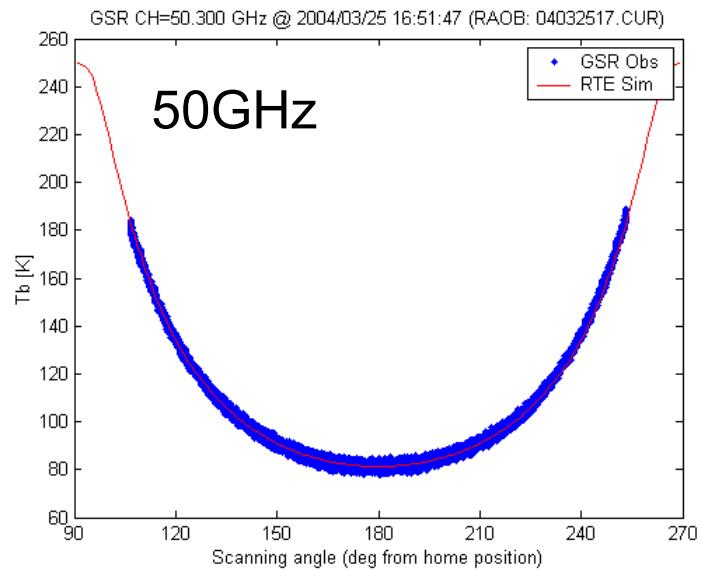
Comparison of Tb forward models for a Chilled Mirror Humidity Sensor



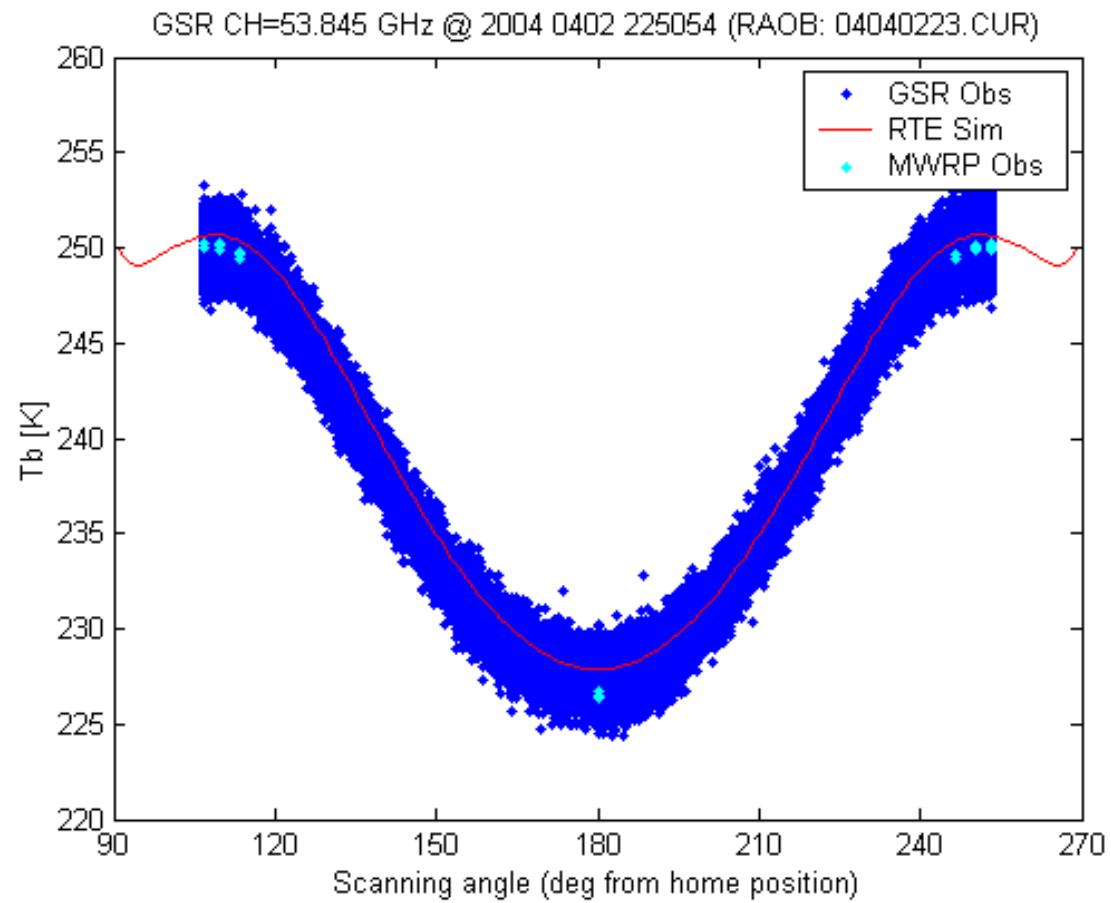
Comparison of Tb forward model (ROS03) for five simultaneous Radiosonde launches



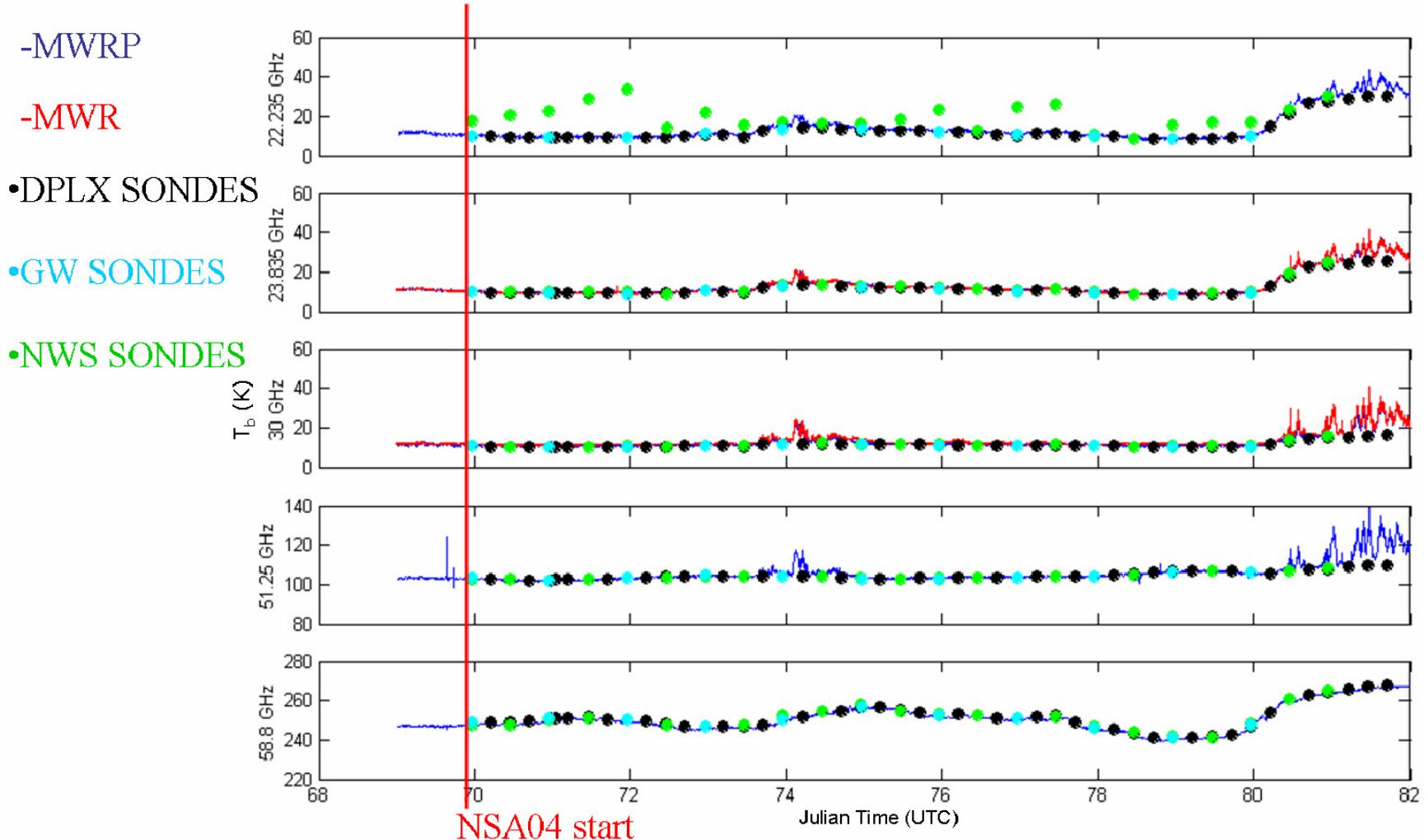
EXAMPLES OF ANGULAR SIGNATURE: GSR and RAOB



EXAMPLES OF ANGULAR SIGNATURE: GSR, RAOB and MWRP

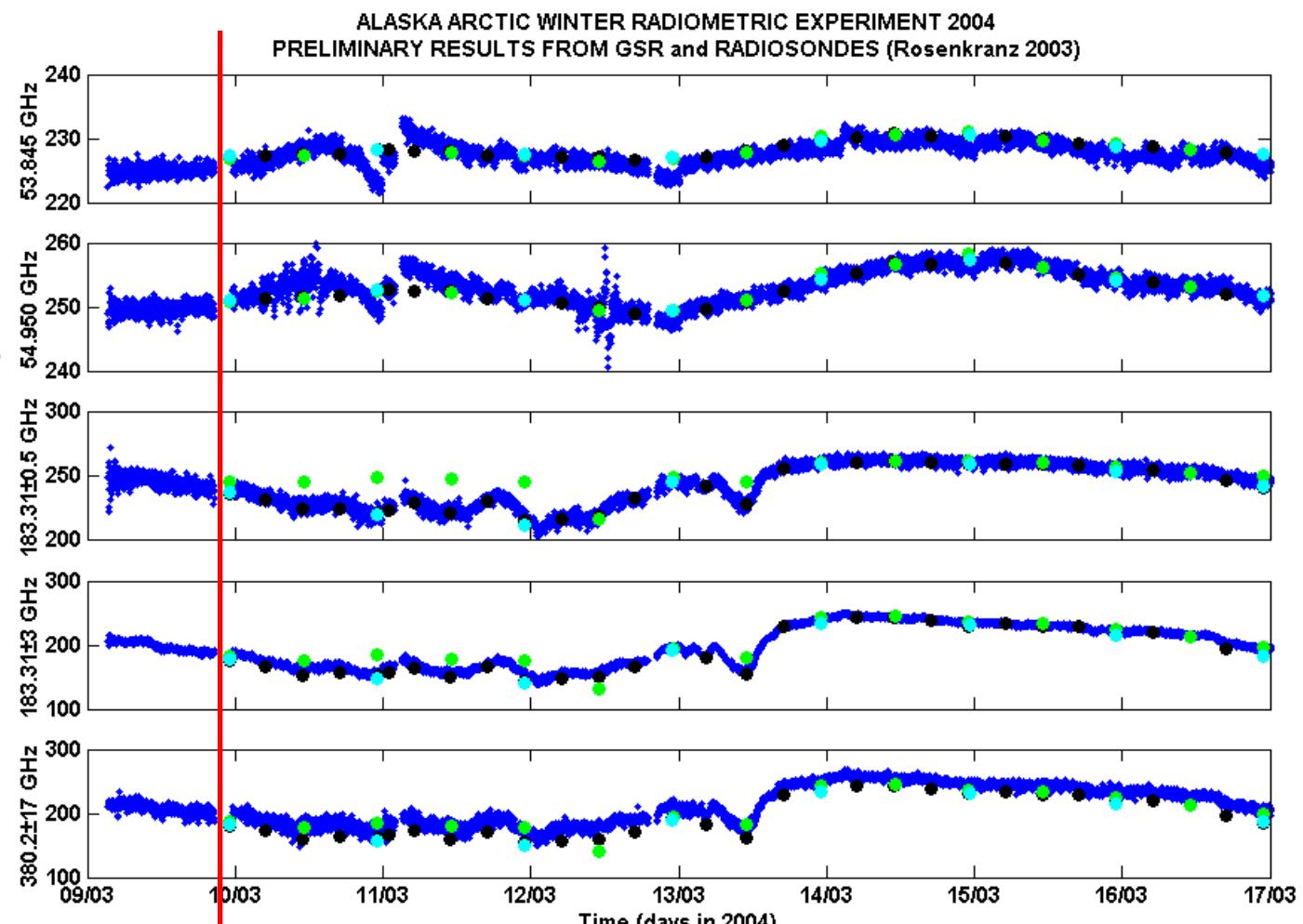


FORWARD MODEL STUDIES USING ARM RADIOMETERS (ROSENKRANZ 03)



TIME SERIES OF GSR and PROCESSED RADIOSONDES

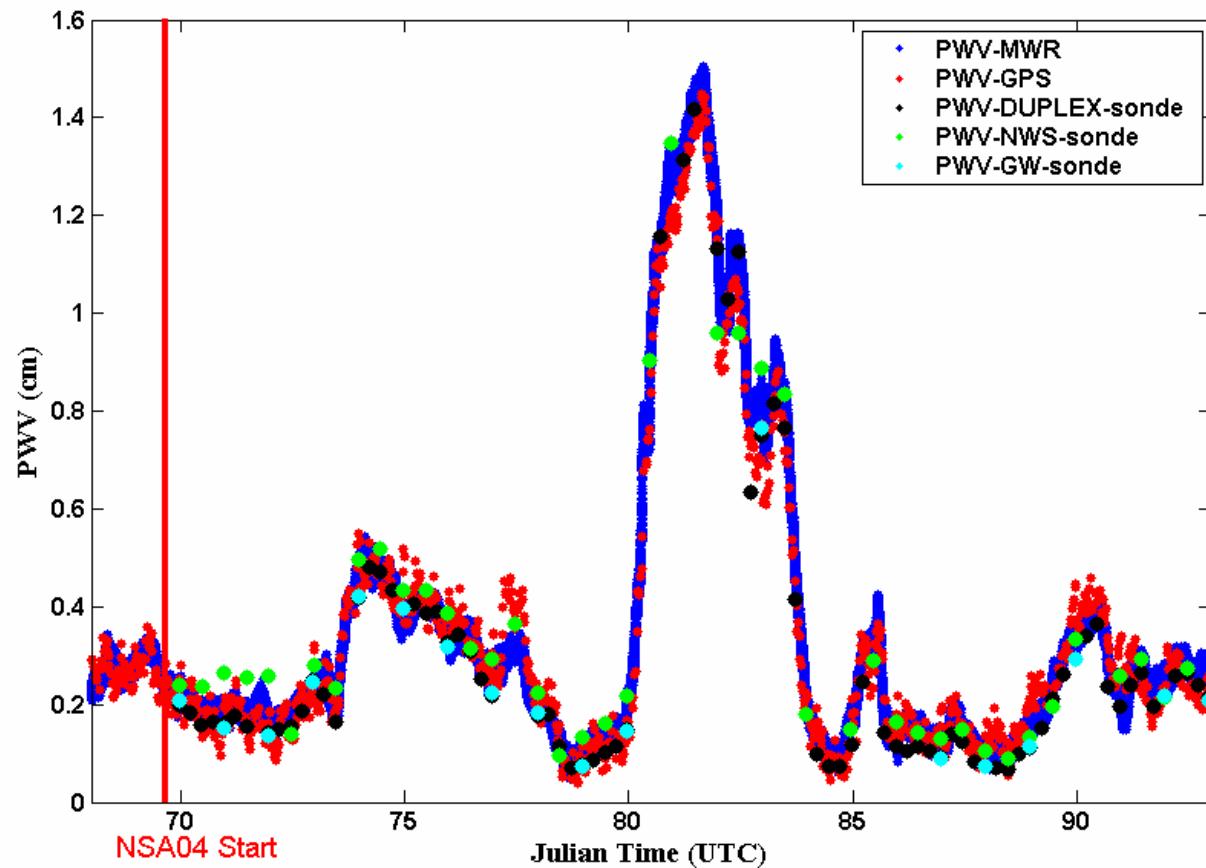
- GSR
- DPX SONDES
- GW SONDES
- NWS SONDES



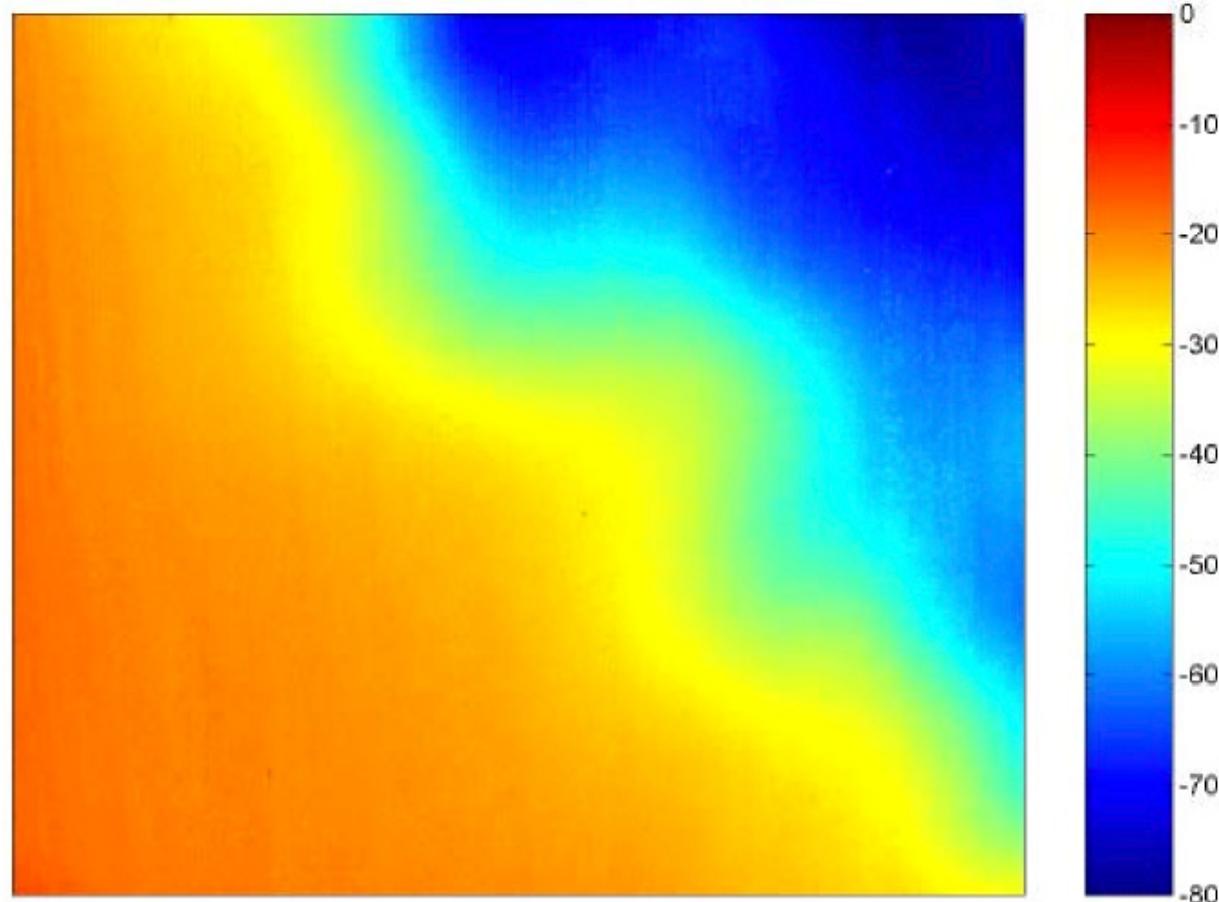
NSA04 Start

GPS VS. MWR PWV COMPARISONS

Barrow, AK March 9 – April 2, 2004



**Infrared Cloud Imager (ICI): Spatial cloud coverage
8-14 microns: developed by Joe Shaw (Univ. of
Montana)**



ICI image of a clearing stratus cloud in Alaska

MAJOR RESULTS TO DATE FROM NORTH SLOPE OF ALASKA ARCTIC WINTER RADIOMETRIC EXPERIMENT

- SUBSTANTIAL DIFFERENCES BETWEEN 5 ABSORPTION MODELS BETWEEN 20 AND 400 GHz (UP TO 20 K)
- SUBSTANTIAL DIFFERENCES BETWEEN VIZ AND VAISALA RS90 RAOBS, ESPECIALLY ABOVE 10 KM (UP TO 20 K)
- DATA FROM GSR, MWR, AND MWPROFILER APPEAR TO BE OF HIGH QUALITY

FUTURE STUDIES

- CALIBRATION STUDIES USING EXTERNAL TARGETS, INTERNAL TARGETS, AND TIP CAL
- FORWARD MODEL STUDIES USING ALL MEASURED TB'S (BOTH FREQUENCY AND ANGULAR DATA)
- T, WATER VAPOR AND CLOUD LIQUID PROFILE RETRIEVALS USING BOTH FREQUENCY AND ANGULAR DATA